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ABSTRACT

Research on the role of educational radio in the classroom sponsored by the Agency for International Development over a ten-year period in Nicaragua, Kenya, and the Dominican Republic is reviewed. An introductory section outlines the reasons for using radio for instructional purposes: (1) it is widespread and democratic; (2) serious radio use is still a novelty in most classrooms; (3) it can entertain and teach simultaneously; (4) it can establish a uniform standard of excellence; (5) it can use the best educational methods; (6) it is cost-effective; and (7) it is familiar technology. Four landmark programs are described, including a primary level radio mathematics project in Nicaragua, a five-year language arts project in Kenya, a Dominican Republic basic education program for out-of-school children aged 7 to 14, and a yet-to-be implemented science project. Lessons learned from past experience with instructional radio are examined, and include the potential for its use, how children learn with it, techniques and advantages of intensive use, the need to stimulate pupil participation and immediate feedback, the advantage of using distributed learning principles and devoting each lesson to a variety of topics, enhancing the role of teachers and parents, the availability of low cost instructional aids, and the reliability of equipment. (MSE)

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INTERACTIVE *radio* IN THE CLASSROOM

TEN YEARS OF PROVEN SUCCESS

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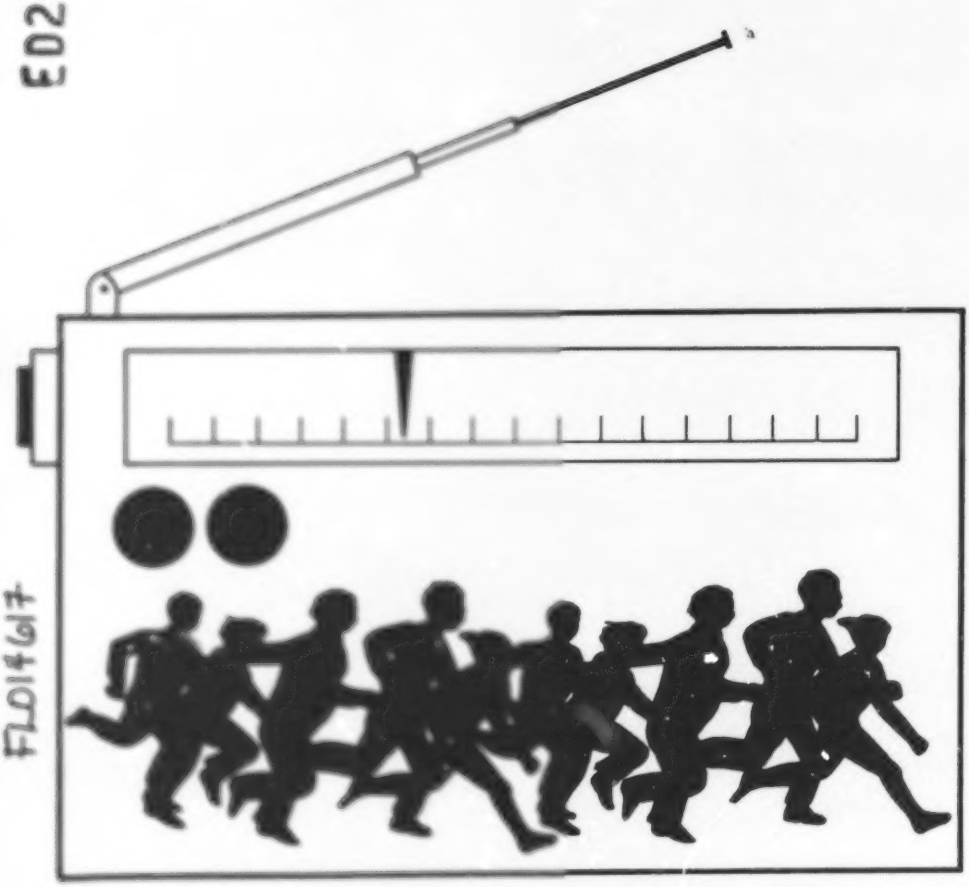

Radio can reach across hundreds of miles into rural classrooms. It can bring the best of instruction and a national curriculum to these distant schools, giving support to the teacher and a new vision to the students. Quality radio instruction can be as affordable as teacher training or textbooks.

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RADIO IN THE CLASSROOM

Ten Years of Proven Success

This paper provides a brief overview of the research on radio's educational role in the classroom sponsored during the last decade by the Office of Education, Bureau for Science and Technology, Agency for International Development.

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RADIO IN THE CLASSROOM
Ten Years of Proven Success

In Nicaragua, pupils who were taught mathematics by radio learned better than students in traditional classrooms, in some cases up to 50 percent more. **In Kenya**, more than 2,000 rural children in seven different linguistic regions are now learning English by radio. After one year of broadcasts there, first grade pupils gained 50 percent in aural comprehension of English and 23 percent in reading skills over pupils in conventional classrooms. A new program in **the Dominican Republic** is using radio to cover a broad basic education curriculum for children who have no access to formal schools. Preliminary results show first-year gains of 60 percent by radio students over control students. **In Nepal**, more than 6,000 primary teachers have studied for their School Leaving Certificates by radio.

More than 600 million adults remain functionally illiterate in the world today. Educational opportunity is unequally distributed between urban and rural, rich and poor, and male and female populations. Student performance in developing countries, as compared to that of similar age groups in developed countries, is often low. Educational infrastructure, schools, teacher training, materials, and administration are inadequate to meet the present needs. Rapid population growth has often erased hard-earned progress. Even though more children are being educated today, the actual number of unschooled individuals increases each year in many developing countries.

In response to these problems, **the Agency for International Development** has initiated an aggressive program of educational assistance. New resources are now available through the Agency's **Office of Education, Bureau for Science and Technology (S&T/ED)** for the analysis of educational problems and the cooperative planning of new programs and strategies. Special attention is being given to the problems of educational management, student retention and promotion, and improved academic performance. The fundamental goal of this program is the widespread expansion and diversification of educational opportunity.

To support these goals, the Office of Education has been privileged to cooperate with the Governments of Nicaragua, Kenya, and the Dominican Republic in an unprecedented **10-year program of educational experimentation.** Recognizing the widespread availability of radio and confident that this simple and cost-effective technology can somehow be used to contribute to better classroom instruction, these governments have created a **major breakthrough in our ability to reach more children with better instruction at lower per-student cost.** Working with S&T/ED they have gone beyond the cosmetic use of radio to "supplement" teachers and shown conclusively that **systematic radio broadcasts can carry the principal instructional burden in the key subject areas of mathematics, language arts, and basic skills.** Daily half-hour programs broadcast to first, second, and third grade students have produced dramatic gains in student achievement without the need for significant retraining of teachers or large investments in textbooks and other materials.

WHY RADIO?

➡ **Because radio is widespread and democratic.** There are now some 5,500 radio stations in the world and over two billion receivers, one for every five people on the planet. As illustrated below the distribution of receivers and broadcast stations varies significantly from one region to another.

UNDEVELOPED COUNTRIES

REGION	NO. OF RADIO STATIONS	NO. OF TV STATIONS	POPULATION (in 000s)	NO. OF RADIO RECEIVERS (in 000s)	% OWNING RADIOS	NO. OF TV RECEIVERS in (000s)	% OWNING TV
Asia	1,364	50	2,626,314	119,014	4.5	40,859	1.5
Africa	251	188	483,360	29,695	6	7,166	1
Oceania	24	8	5,157	969	19	209	4
Europe	--	--	--	--	--	--	--
N. & S. America	3,935	65	386,573	89,522	23	36,416	9
TOTAL	5,574	311	3,501,404	239,200		84,650	

Radio's effective reach, or the number of people who own and listen to radio, is also impressive. Recent studies in The Gambia, for example, show that 59 percent of village families own a working radio, and listening is particularly high at certain hours of the day. Studies in these countries show marked variation in different groups' access to radio, in the number of radio programs heard, in listening times, and in the credibility of radio as a source of information on various topics, but all studies show significant radio ownership and listenership among all social classes even in the world's poorest nations.

➡ **Because serious use of radio is still a novelty in most classrooms.** While widely available in homes and villages, radios are not typically present in most school rooms. Only a few countries have regular classroom instruction via radio. Radio in the classroom still retains the attraction of novelty. Quality radio programming which is both entertaining and educational can create excitement and innovation in even the most isolated rural school. General familiarity with the technology, coupled with ease of maintenance, relative reliability of battery supplies, and the attractiveness of the medium make radio an ideal choice for classroom instruction.

➡ **Because radio can entertain and teach at the same time.** During a typical radio lesson in Kenya, for example, children are asked to sing a song:

"We have done it!
We do it every day.
We have done it!
We did it yesterday.
What are we doing?
We are growing, so are you.
We are growing, growing, growing,
And we're learning English too!"

While singing, they are reinforcing an important lesson--the contrasting verb forms of do, did, are doing, and have done. The program switches immediately to a reading exercise in which pupils read from the blackboard and from their worksheets. Radio is fun but behind the entertainment is a carefully orchestrated plan for introducing new concepts, practicing new skills, and reviewing old lessons.

Most importantly, radio stimulates the children to act--talk, sing, move, think, interact with the familiar voices of the characters they come to love. Studies show that children in these radio classes respond at a rate ten times that of children in regular classes.

➡ **Because radio can establish a uniform standard of excellence.** The untrained teacher may lack knowledge and skills in the content areas, for example math, science, or English. Radio can bring expert instruction into the classroom in support of the inexperienced teacher. Radio lessons can be designed and produced to take advantage of the most qualified teachers available for planning, writing, and teaching. Because of the numbers reached, more effort can be put into planning, more people can work on one activity. A standardized, high-quality instructional program is then available to all students irrespective of the quality of the particular classroom teacher.

Equally important, radio paces the lessons, providing variety, enthusiasm, intensity, and structures the sequence of learning activities. Although radio cannot adjust to the moods of individual students, it does bring organization and intensity to a lesson that in the hands of an inexperienced teacher may be otherwise chaotic and ineffective.

➡ **Because radio instruction can be based on the best of educational methods.** Radio programming lends itself well to the use of instructional design principles, with very clear objectives and instructionally effective techniques. Equally important, it permits programming to be tested on the basis of student learning and reward until it works.

➡ **Because radio is cost-effective.** While the initial cost of developing quality radio programs can be high, these costs are offset by savings in other areas and the unique potential of radio to serve so many children simultaneously. Radio programming requires fewer print materials and textbooks, and reduces the need to maintain cumbersome distribution systems for these materials. Teacher training, particularly in-service, can be made less costly. Quality radio lessons can provide regular orientation to teachers and headmasters in order to maximize effective use of the broadcasts.

An analysis of per student costs is perhaps the most encouraging argument for radio. Once radio lessons have been developed the cost per student per year is very low because the same lessons can be transmitted to thousands--even tens of thousands of new students at minimal additional costs. In Nicaragua, for example, this cost was determined to be between $.50 and $.75 per student.

Analyses of the Nicaragua Radio Math project further suggest that using the radio instructional program may decrease the rate at which students repeat first grade, and by implication, other grades. If this holds true in other

settings, the overall cost to the Ministry of Education of educating a student through the primary grades would decrease. Calculations show that if the repetition rate decreases by only two students per classroom, the radio program pays for itself. The extent to which radio instruction prevents children from leaving school and the resulting benefit to the nation is incalculable.

➡ **Because radio is a familiar technology.** No country on earth is without a radio station. In most developing countries radio is considered the primary contact with urban and rural populations.

Unlike other technology transfers, investments in radio programming do not require significant hardware training. Emphasis can be placed immediately on software development where the largest educational pay-offs are possible. In the classroom radio is familiar to teachers. They feel in control and accept radio programming more willingly than other technology innovations. Broadcasting often attracts some of the most creative and talented people in these societies. They are career oriented and tend to remain in broadcasting, providing a cadre of well-experienced technical and creative specialists difficult to replicate in other areas.

FOUR LANDMARK PROGRAMS

Recent reviews of radio in development, including the World Bank's communications-by-sector papers and the AID-supported series of Project Profiles, produced by S&T/ED's Clearinghouse on Development Communication, document two decades of radio in development. Particular examples include the **Nicaragua Radio Mathematics Project**, **Kenya's Radio Language Arts Project**, and **Radio Basic Education** in the Dominican Republic, as well as **Teacher Training through Radio and Correspondence** in Kenya, **Radio Santa Maria** and its formal and nonformal use of radio for education, **Interactive Radio for Health Care and Education** in Alaska, and the **Community Use of Radio** in Canada. Analysis of these programs makes an important contribution to our overall understanding of how radio can best be used to support systematic educational programming.

Unfortunately, only a few of these programs have been evaluated, and even fewer have been rigorously examined. One of AID's special contributions has been a decade of sustained research and development that has produced a series of successful projects with verifiable and convincing data to support their claim to success. A review of AID's research in this area provides useful evidence for radio's overall potential in the classroom.

The following section provides brief summaries of the four radio education programs being supported by S&T/ED. Each of these programs is described in greater detail in accompanying materials which also contain sample radio programs and scripts. Each program has been rigorously evaluated and detailed findings are provided within the lengthy descriptions.

Radio Mathematics Project

The Radio Mathematics Project was an innovative effort to bring together two related technologies--radio and systematic instructional design--and to evaluate their effectiveness in teaching primary school mathematics. The project operated in Nicaragua, a developing country which, like many others, suffers from a scarcity of fully qualified teachers, particularly in schools outside major urban areas. In such settings, traditional primary school curricula often do not serve the basic literacy and numeracy needs of rural students. The Radio Mathematics Project attempted to improve the quality of mathematics instruction with a curriculum focused on basic skills in a context relevant to the rural children it serves.

Initiated in 1973 by Stanford University's Institute for Mathematical Studies in the Social Sciences, the project was a joint venture of the U.S. Agency for International Development and the Nicaraguan Ministry of Public Education. The program functioned entirely within the formal primary school system. Radio, the main instructional medium, was used to broadcast daily lessons to children in the second, third, and fourth grades of public school.

The project began operations in Nicaragua in June 1974 and pilot-tested the first lessons shortly thereafter. The first full instructional program--for first grade--was developed and field-tested during the school year of 1975 (the Nicaraguan school year runs from February to November). An additional grade-level was developed each year until fourth-grade lessons were completed. Until the recent events in their country, the Nicaraguans were in the process of developing fifth-grade lessons without Stanford's assistance.

The daily mathematics lesson consisted of a 30-minute radio segment and post-broadcast activities conducted by the classroom teacher with the help of a teacher's guide prepared by project personnel. Lessons were broadcast at a fixed time each morning by the national radio station. They consisted of a series of instructional and entertainment segments, designed to elicit four to five active responses (writing answers, responding aloud, singing) per minute from the children. The pacing gave the children the illusion that the radio was listening to them and that it was attentive to their responses. After the radio broadcast, the teacher continued the lessons for the remainder of the mathematics period. Teachers were encouraged to adapt activities suggested in the teacher's guide to the needs of their students. Weekly achievement tests were given in selected classes to determine the students' progress and the need for adjustments in the curriculum plan.

An evaluation of the project conducted in 1976 showed that students in the experimental radio classes scored significantly higher on tests than their non-experimental peers: the mean post-test item score for the experimental groups was 65 percent, for the control group, 40 percent. Later, formal evaluations revealed even greater advantages for the radio classrooms.

At the time of the revolution, the program was used in only four of the country's 16 departments. The Nicaraguan government, however, planned to expand use of project lessons to the entire country. In early 1979, under the direction of the Government of Nicaragua, the program was reaching about 10,000 students.

The designers of the Radio Mathematics Project took into account the experiences of other mediated programs during the development and testing of a radio-based instructional model. The methodology employed by the Radio Math Project was, in fact, intended to be a generalizable system, applicable to other subject areas in different country contexts. The important contributing factors to the effectiveness of Radio Math--the use of frequent student responses, frequent review so that math skills are not lost, the emphasis on formative evaluation, and the ongoing consideration of cost factors and principles of sound operational implementation--are of significance to those who will be planning adaptations of the project in the future.

Radio Language Arts Project

The Radio Language Arts Project (RLAP), a five-year research and development project, focuses on using mass media for development within the context of the formal educational system. Its specific purpose is to develop, implement, and test the effectiveness of an instructional system that uses radio intensively to teach English as a foreign language at the lower primary school level (grades one to three). Its setting is Kenya, a leader on the African continent in the use of media for development.

The primary significance of the Radio Language Arts Project to the study of mass media and development lies in its emphasis on applications of broadcast radio with strong theoretical potential but limited practical success. Specifically, the RLAP is operating in the formal education sector at a time when many experts believe radio to be better suited to nonformal education. It is using intensive radio-based instruction instead of the

normal practice of using radio to supplement more conventional teaching methods. It is systematically evaluating the effectiveness of formal, intensive radio in teaching English as a foreign language to young children, and documenting the techniques used to achieve these results when there is little hard evidence or detailed methodological description of successful radio language teaching available in the literature.

The RLAP envisions interactive radio as an appropriate, cost-effective technology to reach the disadvantaged rural population for whom educational opportunities are frequently limited because of poor educational resources. For this reason, among others, English-language arts programs are broadcast as part of the normal school curriculum during school hours. The daily 30-minute lessons fit into the regular English period in the school timetable. Radio is the major medium of instruction, but teachers have an important role during the broadcasts, in pre- and post-broadcast activities, and in teacher-led complementary lessons. The radio lessons are designed to assist teachers in the classroom, enhancing their effectiveness in teaching a difficult and important skill.

1984 marks RLAP's fourth year of operation in Kenya. The initial year was spent in establishing the project (including assembling the professional team, selecting schools, and finalizing the research design), analyzing the Kenyan English curriculum, and field-testing a variety of methodologies for teaching English by radio. Regular broadcasts to 31 project schools in seven districts began with standard (grade) one in 1982. Standard two lessons were broadcast to the same cohort of children in 1983, and standard three in 1984. The achievements and costs of this method will be analyzed after the conclusion of the 1984 school year, based on the results of three years of broadcasting.

One of strengths of the Radio Language Arts Project is the instructional design principles on which it is based. Several of these are applications of approaches validated by the Radio Mathematics Project.

- **Intensive Use of Radio.** RLAP children are exposed to instructional radio for learning English almost 25 times as long as their counterparts in control classrooms.

- **Cost Control.** The project minimizes two particularly significant costs: printed materials and teacher training.

- **Systematic Instructional Development.** The RLAP is not a curriculum development project. Instead, it seeks to determine how the existing curriculum can best be taught with the help of radio.

- **Distributed Learning.** A given competency is taught over several consecutive lessons. After a period of several weeks, it is maintained over several more lessons.

- **Active Learning.** Children learn better when they are actively involved in the learning process. Writers try not to let more than 15 to 20 seconds lapse without requiring some sort of response from the children.

- **Immediate Reinforcement.** Learning is enhanced by immediate feedback to the learner. The radio gives pupils correct answers to problems as often as possible.

- **The Teacher/Radio Partnership.** The basic role of the radio lessons is to enhance the classroom teacher's effectiveness. The techniques used include systematic coverage of the curriculum, a strong model of correct English, sophisticated pedagogy, maximum exposure to the target language, and lessons that can capture children's attention and motivate them.

Results from the Radio Language Arts Project strongly suggest that intensive instructional radio will prove to be an effective tool for teaching English to rural primary school children. Pupils have already demonstrated significant gains in listening and reading comprehension. Teachers, headmasters, and parents are convinced that this method works. They see improvement in their children's English, and they want to continue with the project.

Radio Basic Education

Radio Basic Education, called RADECO in the Dominican Republic, is the third in S&T/ED's research and development programs with radio. It is a departure from the school-based formula developed in Radio Math and Radio Language Arts. RADECO reaches out-of-school children between the ages of 7 and 14 with regular daily instruction in three broad areas--mathematics, language arts, and life skills including science and social studies. Classes take place in rural communities around the small Dominican town of Barahona. One hour a day for five days a week, radio broadcasts a full curriculum in these three areas. Building on the lesson development and formative evaluations of both Radio Math and Radio Language Arts, the RADECO team began broadcasts in January of 1983. Presently, some 1,000 children in 23 surrounding communities are participating in the program. They meet in an enramada, or shelter, with a local volunteer who helps to stimulate student interest and acts as the community representative for the radio program. Radio lessons are broadcast in the afternoon, between 4 and 5 p.m. to permit the children to complete their workday. InterAmerica Research Associates has been working under the S&T/ED-sponsored contract to develop the radio programs, select the community volunteers, and leave behind a trained staff of Dominicans.

Most lessons are divided equally between math and language arts skills, with entertainment, physical exercise, and health messages sandwiched between the rapidly paced programs. Again, this approach builds on what proved to be successful in Radio Math and Radio Language Arts.

Because the RADECO program works outside the formal school system, it has faced additional elements not common to its predecessors. For example, community relationships have played a much more important role in the project's development. At the same time, it has faced a series of unique problems, many of which have not yet been solved. The fast-paced lesson structures have been difficult to introduce. Early programs, reflecting the

lack of adequate staff training, were less effective than hoped. The interface of nonformal curriculum and official accreditation has been a continuing issue. Nevertheless, initial results are extraordinarily encouraging.

Radio Science

The Radio Science Project, to be implemented within the next few months, follows on the success of using instructional radio to teach a variety of subjects at the primary level. This new project is to develop a tested model for providing low cost, effective primary science instruction with the assistance of radio.

The Radio Mathematics project demonstrated that significant improvements in the learning of mathematics at very low cost is possible through the use of radio. Adaptation of these radio programs in Thailand, despite the cultural and language differences, also showed significantly improved learning of math. The Radio Language Arts Project, carried out in Kenya, is now producing significant gains in learning English. The Radio Science Project will follow on these in-school programs which experimented successfully with instructional radio broadcasting as a means of increasing the quality of education at a low cost.

Rapid technological development far outstrips the pace at which social and political systems change. As the world population increases, it will be important for all members of society to think of themselves as living and functioning within a finite environmental system. Science, as both an understanding of the basic principles and disciplines that shape our lives and the process of empirical discovery that makes these disciplines possible must be made available to all. Technology transfer, modernization, equity, and liberty itself depend to a great extent on the the ability of all people to understand and use science.

A country's ability to use the advances in science and technology to stimulate economic development and to enhance the quality of life of all its citizens depends not just on educating and training the labor force, but also on ensuring scientific and technological literacy among the general population. Education and training programs must prepare all citizens to be full and active participants in an economic and social structure.

Like its predecessors, Radio Science has two fundamental goals: first, to demonstrate that systematic radio instruction can improve student performance, and second, to do so in a way that is affordable and manageable. By relieving some of the economic constraints on primary education including teacher training and teaching materials, AID hopes to show that quality science instruction that is relevant to the host country can be implemented and can help in the economic and personal development of citizens.

The Radio Science Project will combine radio as the major medium of instruction with additional support from classroom teachers and a science education resource center to provide a range of educational experiences in science that is closely tied to the culture and environment of the country in which the project operates.

LESSONS FROM PAST PROGRAMS

The Potential for Instructional Radio

The thrust of the S&T/ED-sponsored radio projects has been to validate a variety of methods for maximizing the effectiveness and minimizing the cost of instructional radio.

Advantages of interactive instructional radio are numerous and have been proven so in S&T/ED's previous programs. Relative accessibility is one of radio's important advantages. In many developing countries the relatively low cost of radio in comparison to other media (such as television and even print media, when printing and distribution costs are considered) has resulted in the wide distribution and use of radios.

The servicing of simple radio receivers is far less difficult than that required for more complicated broadcast technologies. Radio does not require the kind of expensive, cumbersome distribution system that so often finds textbooks in cities instead of in rural schools.

As an aural medium, radio can reach nonliterate audiences. This is generally seen as an advantage in adult education, but it is equally valuable for the education of young children. For them, radio can be used long before textbooks are practical.

Radio can be combined easily with other instructional modes. Simple printed matter or props can be used to add a visual component to a radio-based lesson without detracting from the aurally presented message. Well-designed radio instruction can integrate classroom listeners into the programs.

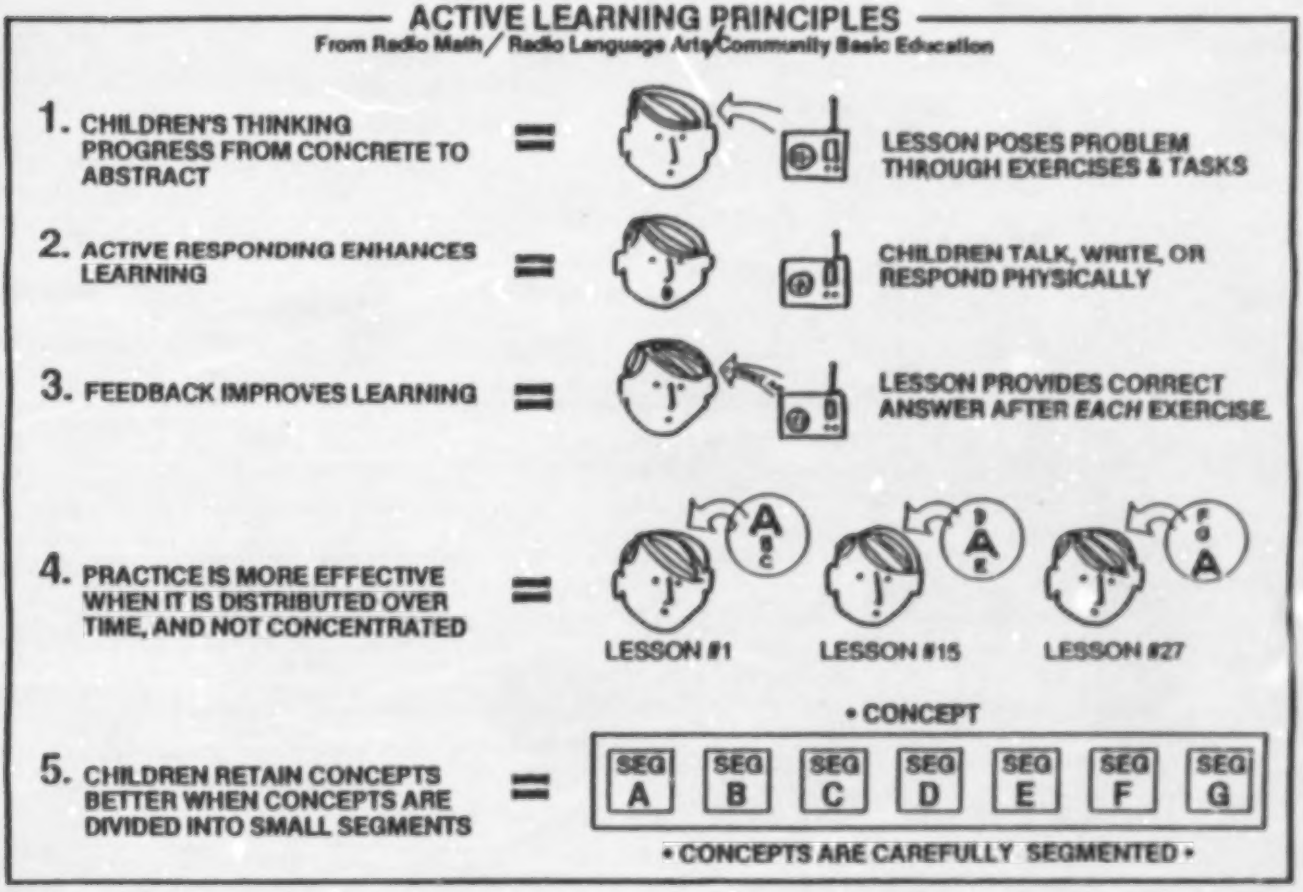
As a broadcast medium, radio requires centrally developed programming. For educational purposes, this allows a degree of control over content and pedagogy that cannot be achieved through textbooks or teacher training. In the case of science instruction, for example, radio curriculum developers can have a direct influence over teaching methods as well as content that may make possible a successful implementation of process-oriented science education that is sensitive to cognitive development constraints.

Radio instruction also presents special challenges. Start-up costs can be high, particularly for new, innovative series such as the S&T/ED-sponsored projects. Broadcast radio is inherently a one-way medium, somewhat limiting the possibilities for responding to and reinforcing pupil responses in the classroom. Radio lessons proceed at their own pace, independent of the listener's response and traditional educators often question radio's ability to visualize key aspects of science demonstrations or experiments.

Perhaps the most important achievement of the S&T/ED-sponsored radio projects has been to demonstrate how radio instruction can overcome each of these obstacles. The following section describes some ways in which this has been accomplished.

How Children Learn by Radio

The key to achieving the potential of radio lies in a clear understanding of how children learn by radio and an ability to apply that understanding systematically. The following principles provide the foundation for a successful project.


ACTIVE LEARNING PRINCIPLES
From Radio Math / Radio Language Arts/Community Basic Education
1. CHILDREN'S THINKING PROGRESS FROM CONCRETE TO ABSTRACT
=
LESSON POSES PROBLEM THROUGH EXERCISES & TASKS
2. ACTIVE RESPONDING ENHANCES LEARNING
=
CHILDREN TALK, WRITE, OR RESPOND PHYSICALLY
3. FEEDBACK IMPROVES LEARNING
=
LESSON PROVIDES CORRECT ANSWER AFTER EACH EXERCISE.
4. PRACTICE IS MORE EFFECTIVE WHEN IT IS DISTRIBUTED OVER TIME, AND NOT CONCENTRATED
=
LESSON #1
LESSON #15
LESSON #27
5. CHILDREN RETAIN CONCEPTS BETTER WHEN CONCEPTS ARE DIVIDED INTO SMALL SEGMENTS
=
• CONCEPT
SEG A
SEG B
SEG C
SEG D
SEG E
SEG F
SEG G
• CONCEPTS ARE CAREFULLY SEGMENTED •

Rigorous Instructional Design. The key to ensuring that children learn efficiently through radio lessons is to design the lessons following a set of systematic, sequenced, and practical procedures. If instructional design is haphazard, the benefits of central control over content and pedagogy are lost. There is no way to ensure that the entire curriculum is covered completely and effectively. Those components that are more difficult to teach by radio, or that fall outside of the professional team's strengths and interests, are likely to be neglected. If instructional design is not practical, precious resources will be expended in a fruitless effort to pursue academic goals unsuited to the realities of cost-effective education in the developing world.

Instructional design must begin with a curriculum. The S&T/ED Radio Projects are not curriculum development projects. The projects remain faithful to the approved syllabus of the host country, particularly as it is reflected in standardized national examinations. The primary focus is on methodology--how the agreed-upon curriculum can best be taught with the help of radio.

The curriculum must be translated into an instructional design document (IDD) that can be used to direct the writing and evaluation of the various system components. The IDD becomes the primary source of guidance to the content specialists and to the curriculum and materials specialists on a lesson-by-lesson basis.

The IDD is often organized by weeks. For each week, measurable instructional objectives (cognitive, affective, and psychomotor) are specified for each content area being covered at that time. These objectives are categorized by appropriate instructional media; that is, whether a given objective can be taught using the radio only, whether ancillary materials (printed booklets, apparatus, etc.) are required, and what non-radio (teacher-led) classes are needed for objectives that cannot be completely or efficiently taught by radio. The larger context of the week's objectives, in terms of the overall organization of the curriculum, will be elucidated, and general pedagogic approaches and examples of the intended content for the week may be given. If the instruction is to be carried out in English, a second language for the students, a cumulative vocabulary list may be provided to indicate what scientific words have been mastered and what words may have to be taught for the first time.

The objectives and recommendations in the instructional design document are used by the lesson planners to specify the content of every segment of every radio lesson and of all ancillary materials. These instructional objectives also provide the basis for the formative evaluation system which lies at the heart of program success. Once the radio lessons have been broadcast, student performance is measured against this standard. Where performance is inadequate, the instructional methodology is revised (in part on the basis of the observers' reports from the schools), and the objectives will be covered again in future lessons. The cycle continues until all objectives have been mastered satisfactorily by students in the schools.

Intensive Use of Radio. Radio lessons cover as much of the curriculum as possible independent of support materials and teacher ability. The goal is to ensure that a child in a classroom with inadequate resources and an unqualified teacher can achieve the basic objectives of the intended curriculum. Better teachers with more resources build on this foundation and foster even greater student achievement.

Explicit in the program is the reliance on radio as the primary means of instruction. Radio Math produced 170 half-hour lessons per school year, Radio Language Arts, 195. In Kenya these lessons were longer than the normal primary English radio programs (30 minutes instead of 15), were more frequent (new lessons daily instead of weekly), covered more of the school year (broadcast 39 out of 40 weeks instead of 24 out of 40), and began earlier (at the first year of primary school instead of the second). Over the first three years of primary school (the focus of the Radio Language Arts Project), RLAP

children will have listened to 292.5 hours of radio English lessons compared to the 12 hours of new radio instruction received by children in conventional classrooms in the same period.

Results from both the math and the language arts projects proved that this intensive use of the medium paid off in increased achievement and lower costs.

Frequent Responses. A primary lesson of the previous S&T/ED-sponsored radio projects shows that the involvement of students in the learning process through interactive learning is perhaps the single most important method for achieving the instructional goals of radio. The first key to success in this area is getting children to accept the radio as a window into another world whose characters can communicate with the pupils in the classroom. The instructional objectives for the Radio Project's first lessons must take this into account. Children learn to respond directly to commands and questions from the radio characters during carefully timed pauses in the broadcasts. Because those characters, in turn, seem to reply to the children, a sense of two-way communication can be created. By the second year of broadcasts, this sense becomes a strong foundation for the instructional message.

Once this two-way relationship is established, it is possible for the radio to stimulate pupil participation effectively. Writers must let as little time as possible go by before requiring some sort of response from the children, the exact type of which will depend on the specific instructional objective being treated. In Radio Math and Radio Language Arts this was measured in seconds, with intervals greater than 30 seconds generally considered too long.

Immediate Feedback. Another lesson gleaned from S&T/ED is that learning is enhanced by immediate feedback to the learner. This is also an area in which the one-way nature of broadcast media can cause problems unless appropriate care is taken. The Radio Project lessons are designed to serve teachers who may be weak in the context area, as well as those who have good training and experience. Each segment, therefore, must be planned so that the students benefit from everything that the classroom teacher can contribute, but do not suffer if this contribution is limited. For this reason, too, the radio must give pupils correct answers to problems as often as possible.

Providing immediate feedback is one of the more interesting challenges of the Radio Projects. When the technique was first developed in Nicaragua with Radio Math, it was fairly straightforward: most math problems in lower primary school have only one correct answer. The radio has but to ask a question, pause for the proper number of seconds, and give the appropriate answer. Even when a problem-solving process is being taught, there is likely to be only one correct way of analyzing the problem and arriving at the intended solution.

Radio Language Arts broke new ground in this regard. The open-ended nature of language made immediate reinforcement far more difficult to implement for English than for mathematics. If a child is asked a comprehension question, one correct answer can be modeled. If he or she is asked to generate language naturally, however, there may be a multitude of correct responses. The radio cannot model them all. If a child is asked to

write a response, the radio itself has no way of directly judging or correcting that written response.

Past programs demonstrate, however, that these challenges can be met, and children become involved actively in each radio lesson. Their attention is held firmly, they are better able to acquire new skills, and they are likely to retain those skills more successfully.

Distributed Learning. Psychologists have long known that skills need to be practiced regularly to be maintained effectively, and that learning spread over time (distributed learning) is more effective than learning concentrated in only one period (mass learning). Instructional designers, however, have generally paid only lip service to the implications of this principle. By far the most common mode of instructional organization, whether by classroom teachers or mediated learning packages, is the "topic"--one lesson devoted to one subject.

The challenge of instructional efficiency addressed by the S&T/ED-sponsored radio projects requires the practical application of the distributed learning principle. This is one reason for the segmented script organization adopted by both Radio Math and Radio Language Arts. Rather than devoting one program to a single topic or objective, each program consists of several segments, each teaching or maintaining different objectives. A given objective, on the other hand, is taught over several consecutive lessons. Then, after a period of several weeks, it is maintained over several more lessons.

In addition to improving learning, this approach enhances the ability of the radio lessons to involve pupils. The relatively short attention span of primary school children is better served by a few minutes of concentration on one topic than by an entire half hour. Their interest can be maintained more effectively through the presentation of a variety of materials and through the quicker pace such variety promotes.

Finally, distributed learning introduces the important element of redundancy into the radio lessons. In a more traditional curriculum organization, one broadcast might be devoted exclusively to one topic. What happens if a child misses that broadcast because of sickness or broadcast problems? A classroom teacher would know that this had happened and could take steps to individualize the instruction, perhaps doing extra work with the absent child to cover the missed content. The radio lesson designers, however, will not know as the script is being written that any given child will miss the broadcast, nor could they respond effectively if they did know.

The S&T/ED model of segmented lessons and distributed learning, on the other hand, assumes that only a portion of the instruction for a given area will be covered in a given lesson, and that portion will be reviewed in future lessons. The Nicaraguan and Kenyan projects proved that a child who misses a particular broadcast will be able to cope far more easily in this system.

Engaging Children's Interest. To capture the children's interest the radio programs should be entertaining as well as educational. This is particularly important for a media-based instructional system. As noted previously, radio can encourage passivity if lessons are not carefully

designed. Passivity, in turn, will quickly lead to a loss of attention, and loss of learning. Since the radio has no immediate means to detect this, the goal must be to avoid it altogether.

The S&T/ED model already provides a number of strategies for holding children's interest, strategies so successful in practice that they have succeeded in maintaining high attention levels, even among entering first graders, over a full half-hour broadcast, something that most radio experts predicted could not be done. These strategies include:

- Varied content in each lesson, due to distributed learning.
- Varied pedagogic approaches, ranging from formal didacticism to informal instruction delivered in an entertaining manner.
- Interactive lessons with frequent student responses.
- Enhancement segments with no primary instructional objectives other than to provide a change of pace through songs, games, or physical activities.

Role of Teachers and Parents

Teachers. Teachers need not receive extensive training to work effectively with radio instruction. But they do need to understand the professional underpinnings of suggested reform and come to see the radio as a support, not as a threat.

S&T/ED's radio projects have effectively gained teachers' support. Teachers have come to recognize that radio provides instruction in a content area, or segment of the area, that is difficult for the teachers on their own. Radio in Thailand and Kenya has the strong support of teachers for supplementary broadcasts which bring examples, illustrations, and skills to the classroom that were normally unavailable to the teacher. The more intensive use of radio in the Radio Math Project in Nicaragua, and later in Thailand, also gained teachers' enthusiasm because it provided quality instruction in a difficult subject. Ninety-nine percent of teachers and headmasters in Kenya have indicated their support of radio instruction through the program.

Such enthusiasm for radio is not generated simply by offering it as an alternative delivery system. Indonesia, for example, abandoned a radio teaching program for English language because teachers did not like it. The quality and effectiveness of the program remained untested because it was rejected before it could be evaluated.

The process developed for teacher orientation in the Kenya project provides an effective model for ensuring teacher support. This process includes:

- Understanding the use of radio to support the teacher.
- Sufficient knowledge of the aims of the project.

- Familiarity with the instructional radio process and format, including practice in monitoring a typical broadcast lesson.

- Use of the teacher's notes to make classroom instruction easier and more efficient.

These have all proven achievable with many low levels of investment, less than one day a year of group orientation.

Parents. The effect of parents' attitudes may surface more slowly than teachers, but they are equally important. Parents' attitudes may surface in highly charged, emotional meetings that may threaten or cancel instructional programs.

The process to ensure parent support includes the following steps:

- Assess the perceived needs for educational change.

- Ensure that innovation is compatible with cultural and educational values.

- Demonstrate that innovation leads to improved instruction.

The Radio Language Arts Project followed these steps through clearly articulated activities. Attitudes and needs were assessed during the sociolinguistics survey carried out in the early stages of the project. Cultural and educational values and the tolerance for innovation in methodology and in the use of media were monitored by the Kenyan members of the team through script and production review, through weekly observation in schools, and through discussions with headmasters and teachers. The measurement of the instructional effectiveness is the major purpose of the project's summative evaluation. Parents receive more practical feedback through the parents' committees in schools. (Anecdotal evidence from teachers and headmasters, and, we hope, children, reach parents immediately.) The school committee structure was an established mechanism in Kenya. Where such a channel for parent-school-project communication does not exist, we would recommend its establishment.

Low-Cost Instructional Aids

As explained earlier, one of radio's primary advantages as an instructional medium is that it can reduce or even eliminate the need for textbooks and other expensive instructional aids. The degree to which this advantage can be realized in practice depends in part on the subject area. Radio Math was able to eliminate distributed student materials after the first grade. The broadcasts themselves told children how to prepare their own worksheets. Radio Language Arts minimized the amount of print material required to support its radio lessons. Since children must have material to read if they are going to learn that skill, however, and since not all rural schools are likely to have adequate supplies of textbooks, the RLAP did prepare inexpensive worksheets to supplement its radio lessons.

In the area of print materials, the designers can follow two related strategies. The first is to reduce the amount of materials by maximizing the instructional load carried by the radio and using the teacher/blackboard combination to substitute for printed matter whenever possible. The second is to work with private sector entities to achieve mass production of simple materials at low cost. In addition to the technological questions relevant here, the project's own research and development work can help to illuminate what is and is not necessary for effective print materials. For example, what is the value of color for science instruction in a radio-based system? If color is not cost-effective, significant savings can be achieved by relying on simple, black and white line drawings.

Equipment Reliability

The longevity of commodities purchased for the Radio Language Arts Project in Kenya, for example, is encouraging. Seventy radios (with built-in cassette recorders) were purchased to serve 21 project schools and approximately 45 classrooms. Of these only six have been stolen and another four broken beyond repair. Five are used in the RLAP offices, and 10 more have been distributed to large schools to support the distribution of standard one and two lessons on cassette tape. The project has reimbursed headmasters who have repaired radios locally. The average cost of such repairs is $15, with total expenditures for such repairs over the life of the project under $200.

Office equipment purchased included five typewriters and a photocopier. Audio equipment purchases included a studio tape deck, a field tape recorder, a high speed cassette duplicator, microphones (with stands and cables), and two remote control units for the studio tape machine. All of these are still operating well. Tape stock sufficient for reel-to-reel and cassette copies was purchased and is accounted for, with some attrition in the cassette tapes used for field distribution. Four project vehicles were purchased and are still operating well after an average of 55,000 miles of travel each. Fears that equipment problems would present serious obstacles never materialized.

CONCLUSION

Radio can be an effective medium for addressing educational problems in most of the developing world, problems such as:

- Large school-age populations.
- Poor access to schools for rural children.
- Poor quality of instruction and poorly trained teachers.
- Shrinking educational budgets.
- Curriculum irrelevant to the country's needs.

These difficulties have stimulated the search for ways to overcome them and to improve educational systems so as to maximize slender resources.

Interactive radio can provide uniform, carefully planned and developed curricula, simultaneously delivered to children in urban and rural environments, regardless of the ability of the individual classroom teacher. Once prepared, tested, and corrected, radio lessons can be used again and again, effectively lowering the per-unit costs over time. It is also felt that if the quality is such that the educational goals are met, there will be a substantial reduction in repeating students, thereby reducing the costs per pupil still further. This would also, in effect, free up the space of a repeating student for a new student. Finally, radio has a clear advantage over other forms of learning technologies in providing equity of access because of its broad reach into rural areas and its ability to reach children who cannot get to a physical school site.

The challenge now is to find practical ways of integrating these experiences into the regular educational systems of countries with educational goals for which radio provides an exciting opportunity.